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CONTROL DEVICE FOR VEHICLES
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/1[1]

Specification

1. Title of the invention: Control device for vehicles

[Abstract]

[Purpose] To provide a control device for vehicles which can significantly improve security and protection and minimize the time wasted on disorder recovery without performing unnecessary security operation at the time of initial write-in of the program; also, the process of interruption process can be used for data transfer in the on-board rewriting operation; high speed and highly reliably protocol can be easily adopted; and it enables an on-board reloading system for vehicles configured inexpensively.

[Constitution] A transfer program (15) for an on-board program reloading device (10) is transferred to RAM (7) within a MCU (2), and a flash ROM (4) is reloaded by the action of the transfer program. Prior to starting the transfer program on the RAM (7), the agreement of the code (17a) provided externally and the code (4a)) originally on the ROM is checked. A reloading control means.(6) for stopping the reloading operation when disagree is configured within the MCU (2).

/2

2. Claim

[Claim 1] In a control device for vehicles where a reprogrammable

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[1]Numbers in the margin indicate pagination in the foreign text.

memory means stored with algorithm and data for control and a CPU for controlling the vehicle loading machine based on the algorithm and data of the memory are stored within the processing device and the content of the reprogrammable memory is packed so that it generally cannot be read from the said processing device externally, the control device for vehicles comprises within said processing device with a rewriting mode discrimination means for discriminating the rewriting command from external, a serial communication means for conducting communication with outside, a temporary memory for temporarily loaded with a transfer program loaded from external via the serial communication means at the initial rewriting mode, a rewriting control means for receiving signals of said rewriting mode discrimination means and loading the transfer program to said temporary memory and applying the control to the transfer program by the prescribed timing; it possesses a function of renewing the contents of said reprogrammable memory according to the code received externally via said serial transfer means by operation of said transfer program; the control device for vehicles characterized in that said rewriting control means comprises a function of comparing a code received from external by the prescribed timing prior to applying the control to said transfer program and a code pre-stored in the specific address of said reprogrammable memory and stopping the rewriting mode when they are disagree.

[Claim 2] In a control device for vehicles where a reprogrammable memory means stored with algorithm and data for control and a CPU for controlling the vehicle loading machine based on the algorithm and data of the memory are stored within the processing device and the content of the reprogrammable memory is packed so that it generally cannot be read from the said processing device externally, the control device for vehicles comprises within said processing device with a rewriting mode discrimination means for discriminating the rewriting command from external, a serial communication means for conducting communication with outside, a temporary memory for temporarily loaded with a transfer program loaded from external via the serial communication means at the initial rewriting mode, a rewriting control means for receiving signals of said rewriting mode discrimination means and loading the transfer program to said temporary memory and applying the control to the transfer program by the prescribed timing; it possesses a function of renewing the contents of said reprogrammable memory according to the code received externally via said serial transfer means by operation of said transfer program; the control device for vehicles characterized in that said rewriting control means comprises a function of comparing a code received from external by the prescribed timing prior to applying the control to said transfer program and a code pre-stored in the specific address of said reprogrammable memory and

deleting the entire or partial contents of the specific address of said reprogrammable memory when they are disagree.

[Claim 3] In a control device for vehicles where a reprogrammable memory means stored with algorithm and data for control and a CPU for controlling the vehicle loading machine based on the algorithm and data of the memory are stored within the processing device and the content of the reprogrammable memory is packed so that it generally cannot be read from the said processing device externally, the control device for vehicles comprises within said processing device with a rewriting mode discrimination means for discriminating the rewriting command from external, a serial communication means for conducting communication with outside, a temporary memory for temporarily loaded with a transfer program loaded from external via the serial communication means at the initial rewriting mode, a rewriting control means for receiving signals of said rewriting mode discrimination means and loading the transfer program to said temporary memory and applying the control to the transfer program by the prescribed timing; it possesses a function of renewing the contents of said reprogrammable memory according to the code received externally via said serial transfer means by operation of said transfer program; the control device for vehicles characterized in that said rewriting control means comprises a function of applying the control to said transfer program unconditionally without

comparing the code received from external by the prescribed timing prior to applying the control to said transfer program and a code pre-stored in the specific address of said reprogrammable memory when the content of the specific address above 1 of the reprogrammable memory is in the non-write-in state.

[Claim 4] In a control device for vehicles where a reprogrammable memory means stored with algorithm and data for control and a CPU for controlling the vehicle loading machine based on the algorithm and data of the memory are stored within the processing device and the content of the reprogrammable memory is packed so that it generally cannot be read from the said processing device externally, the control device for vehicles comprises within said processing device with a rewriting mode discrimination means for discriminating the rewriting command from external, a serial communication means for conducting communication with outside, a temporary memory for temporarily loaded with a transfer program loaded from external via the serial communication means at the initial rewriting mode, a rewriting control means for receiving signals of said rewriting mode discrimination means and loading the transfer program to said temporary memory and applying the control to the transfer program by the prescribed timing; it possesses a function of renewing the contents of said reprogrammable memory according to the code received externally via said serial transfer means by operation of said transfer

program; the control device for vehicles characterized in that an interruption vector region of said CPU is taken in the specific region within the reprogrammable memory by the normal mode and an interruption vector moving means is provided within the processing device so that the interruption vector is allowed to move in the prescribed region within the said temporary memory means only during the prescribed period in the mode in the rewriting mode transferred by the rewriting mode discrimination means. /3

2. Detailed explanations of the invention

[0001]

[Industrial Field of Applications]

This invention relates to a control device for vehicles. In particular, it pertains to an on-board reloading technology for control software stored in the control device for vehicles.

[0002]

[Prior Art]

In recent years, large scaled electric reprogrammable memory (E^2 PROM and flash ROM) has been in practical use, and also has been used within the control devices for vehicles. The usage includes storage of control constant and storage of control algorithm, and it is assumed that the following convenience has provided.

[0003]

Software bug found after the product shipped from the automobile maker can be easily corresponded by on-board rewriting by field.

Deterioration and chronological change of the constructional parts of the vehicle can be corresponded by reloading the matching constant stored within the control device.

The control software matching to the configuration when the configuration of the control device is changed by attaching and detaching optional parts after product shipment can be reloaded.

[0004]

For example, the document "Cost-effective field reprogrammable code-flash memory technology.") Spec Publ Soc Automot Eng. NO. SP-739PAGE. 55-59 1988) has clearly described regarding to (1) and (2), and Tokkai H3-149337 disclosed the patent application regarding to (3). Also, the technology of executing reprogramming by read-in the transfer program designed by the user for reprogramming to the RAM region within the one touch microcomputer upon on-board reprogram externally has described in documents such as "H8/538F hardware manual" (by Hitachi Plant, issued by Semiconductor Industrial Department on August 1993, edition 1), which is well known.

[0005]

However, for the on-board reprogramming of the mode of reading the program for reprogram transfer from external and applying the control to it, it is not the standard reprogram, and the possibility of loading false program for the internal information output is inevitable. Also, since the creation method for transfer program for reprogram is generally open to the public, everyone can create transfer program for reprogramming freely. As a result, anyone can easily falsify the internal code by using a false program.

[0006]

For the system permitting reprogramming of the control software and constant by field, the preservation of security of the code and protection of the code from the reprogramming (falsify) other than legal operation become important objects. For example, regarding to the EPROM attached outside, a control system is well known that a check data is created based on the data of the external memory by the prescribed timing, the check data and the check data in the internal memory are compared, and the abnormality mode is set up as the falsifying of the data of the external memory when both are not match (for example, refer to Tokkai H3-238541).

[0007]

[Problems that the Invention is to Solve]

However, the technology for preserving security of the code

and protecting the code from reprogram (falsify) other than regular operation has not developed for one-chip microcomputer for vehicle loading of built in large scale E^2 PROM and flash ROM.

[0008]

Also, when the transfer program for reprogramming created by the user is loaded within the one-chip microcomputer from external and reprogramming is performed, the problem is that the freedom to the algorithm of the reprogramming program is minimized. For example, the interruption vector is normally mapped in the address space on the flash ROM to be reprogrammed, and the reprogramming operation cannot use the interruption process.

[0009]

Taking into consideration of these problems, the purpose of this invention is to provide a control system for vehicles which can significantly improve security and protection and minimize the time wasted on disorder recovery without performing unnecessary security operation at the time of initial write-in of the program; also, the process of interruption process can be used for data transfer in the on-board rewriting operation; high speed and highly reliably protocol can be easily adopted; and it enables an on-board reloading system for vehicles configured inexpensively.

[0010]

[Means for Solving the Problems]

In order to attain the aforementioned purpose, basically, for a control device for vehicles where a reprogrammable memory means stored with algorithm and data for control and a CPU for controlling the vehicle loading machine based on the algorithm and data of the memory are stored within the processing device and the content of the reprogrammable memory is packed so that it generally cannot be read from the said processing device externally, the control device for vehicles comprises within said processing device with a rewriting mode discrimination means for discriminating the rewriting command from external, a serial communication means for conducting communication with outside, a temporary memory for temporarily loaded with a transfer program loaded from external via the serial communication means at the initial rewriting mode, a rewriting control means for receiving signals of said rewriting mode discrimination means and loading the transfer program to said temporary memory and applying the control to the transfer program by the prescribed timing; it possesses a function of renewing the contents of said reprogrammable memory according to the code received externally via said serial transfer means by operation of said transfer program; the control device for vehicles characterized in that said rewriting control means comprises a function of comparing a

code received from external by the prescribed timing prior to applying the control to said transfer program and a code pre-stored in the specific address of said reprogrammable memory and stopping the rewriting mode when they are disagree. /4

[0011]

As preferable concrete examples of this invention, the control device for vehicles characterized in that said rewriting control means comprises a function of comparing a code received from external by the prescribed timing prior to applying the control to said transfer program and a code pre-stored in the specific address of said reprogrammable memory and deleting the entire or partial contents of the specific address of said reprogrammable memory when they are disagree. The control device for vehicles characterized in that said rewriting control means comprises a function of applying the control to said transfer program unconditionally without comparing the code received from external by the prescribed timing prior to applying the control to said transfer program and a code pre-stored in the specific address of said reprogrammable memory when the content of the specific address above 1 of the reprogrammable memory is in the non-write-in state.

[0012]

A preferable working example is that the interruption vector region of said CPU is taken in the specific region within the

reprogrammable memory by the normal mode and an interruption vector moving means is provided within the processing device so that the interruption vector is allowed to move in the prescribed region within the said temporary memory means only during the prescribed period in the mode in the rewriting mode transferred by the rewriting mode discrimination means.

[0013]

[Function]

As described above, for the control system for vehicles of this invention with the aforementioned configuration, by using the knowledge only known by the initial code designer of the one-chip microcomputer as the check code, false program access can be prevented. In other words, the internal code can be deleted and the confidentiality can be protected during false program access. Also, during initial code write-in, the time and labor required for block-out recovery can be minimized so that the unnecessary check operation can be eliminated. Furthermore, creation of the transfer program for reprogram by the user is made easier.

[0014]

[Working examples]

A working example of this invention is described by diagrams in the following. FIG. 1 is a block diagram of a control system for vehicles of a working example of this invention. A MCU (Micro Control Unit) 2 is soldered to the substrate inside the

control system 1 for vehicles. A CPU (Central Processing Unit) 3 in the MCU 2 performs control of the machine by command of the program stored in the flash ROM 4 which is a reprogrammable memory. Normally, the content of the flash ROM 4 is hidden in the resin packing called MCU 2, and cannot be easily read from outside. Therefore, the security and protection of the program can be sustained by this function.

[0015]

An on-board program re-programmer 10 is connected with the MCU 2 by a serial line RX 11 and a serial line TX 12, and performs reprogramming of the aforementioned program from outside. Generally, the MCU 2 is not taken out from the substrate of the automobile control system 1. This mode of reprogramming the internal program by the form of mounting as is called as "on board program reprogram." Since it can be done without taking out the MCU 2 from the substrate, the time and cost required for replacement can be significantly reduced without effecting its electrical reliability compared with the format of EPROM exchange and asshi exchange such as the substrate and unit.

[0016]

The principle of the "on board program reprogramming" is described in the following. An external switch 13 transfers a command of program reprogramming from external to the MCU 2. It

differs by the internal mechanism of the MCU 2, however, normally, it is performed by applying the write-in voltage Vpp (12V) to the prescribed terminal of the MCU 2 and releasing the reset. The reprogramming mode discrimination means 5 discriminates the aforementioned signal and transfers the MCU 2 to the state of reprogramming mode.

[0017]

In the reprogramming mode, the CPU 3 is operated by the boot program stored in the reprogram control means 6, which is not operated by the ordinary control program stored in the reprogrammable memory 4. Data exchange with outside is made possible by this function via the SCI 8 (Serial Communication Interface). On the other hand, the on board program reprogrammer 10 is configured by a SCI 14 similar to the MCU 2, a reprogramming transfer program 15 for transferring to the temporary memory 7 (RAM) within the MCU 2, the exchangeable recording media 17 stored with the code as the renewal content of the reprogrammable memory 4 as the final result, and the communication control means 16 for controlling the flow of the data.

[0018]

The aforementioned exchangeable recording media 17 could be in the forms of electric element such as EPROM, magnetic recording media such as floppy disk, or terminal device such as

keyboard. The MCU 2 transferred to the reprogramming mode transfers the reprogramming transfer program 15 to the temporary memory 7 via the serial line RX 11. Then, the control of CPU 3 is switched over to the transfer program for reprogramming on the temporary memory 7.

[0019]

The reprogramming transfer program is then continuously read in the code of the exchangeable recording media 17 of the on board program reprogrammer 10 via the serial line RX 11, and the content of the reprogrammable memory 4 is renewed. The serial line TX 12 is used for controlling of flow of the serial communication. For example, it is used for reception confirmation signal and data retransfer command from the MCU 2 to the on board program reprogrammer 10. /5

[0020]

If the transfer program 15 for reprogramming is stored in advance as the firmware in the reprogramming control means 6 within the MCU 2, it is efficient since it can be done without transfer to the MCU 2 by an on board program reprogrammer 10 in the initial stage of the reprogramming mode. However, this method cannot be adopted because the following reasons.

The firmware of the reprogram control means 6 becomes large in scale and the cost increases (worked as hard as possible to set a simple boot program).

The communication between the on board program reprogrammer 10 and the MCU 2 and the reprogramming algorithm of the reprogrammable memory 7 are fixed, and there is no flexibility. (the user cannot take charge according to TPO.)

[0021]

Also, it is not required if the reprogram transfer program 15 is placed in the reprogrammable memory 4. However, this method also cannot be adopted because the following reasons.

The system for the initial reprogramming and the reprogramming thereafter must be different. (The transfer program is not existing in the non-reprogramming state.)

The transfer program for reprogramming itself must be modified externally.

The memory block loaded to the transfer program for reprogramming cannot be deleted.

It is troublesome to set and manage the control program of the control device 1 for vehicles and the transfer program for reprogramming simultaneously.

[0022]

The check code 17a contained in the exchangeable recording media 17 is transmitted to the MCU 2 by the prescribed timing via the serial line RX 11. The prescribed timing could be anytime before the reprogramming control means 6 within the MCU 2 transfer the control of the CPU 3 to the reprogramming transfer

for solving the drawbacks. The interrupting vector region is allowed to move to the region 7b within the temporary memory 7 during the operation of the transfer program for reprogramming on the temporary memory 7 by the reprogramming mode. Therefore, the interrupting function can be utilized by the transfer program for reprogramming, and the freedom of the algorithm is increased. FIG. 2 shows the algorithm by a working example of this invention by a flowchart. The algorithm, as mentioned above, is executed by the boot program implemented by the boot program implemented to the reprogramming control means 6.

[0025]

When the boot program of the reprogramming control means 6 is started by receiving a signal of the reprogramming mode discrimination means, first, advance to the block 201, then synchronous process with the external on board program reprogrammer 10 is carried out. Synchronous processing includes matching of the transfer rate of the on board program reprogrammer 10 with MCU 2 and the confirmation process of communication protocol. Then advance to the block 202, and the total number of byte of transfer program that must be received is received. Then, the transfer program is copied to the temporary memory 7 from outside in every byte by the blocks 203, 204, and 205 forming the loop. The loop is continued until the entire transfer program is being copied. Next, the process is advanced

to block 206, and the check code transferred from the on board program reprogrammer 10 is received. The check code 17a and the prescribed code 4a on the reprogrammable memory 4 are compared in the block 207, advance to the block 208 if matches, and transfer the control to the program on the temporary memory 7 which has just transferred. If they do not match, the reprogramming mode is finished by the block 209, and the protection of the code on the reprogrammable memory 4 is performed.

[0026]

Improvement of security and protection of the program can be realized according to this working example. However, for the aforementioned algorithm, if reprogramming operation is executed to the entire code pattern which can be taken by the prescribed code 4a, the protection is broken down sometime. Another working example showing improvement of this aspect is shown in the flowchart in FIG. 3.

[0027]

FIG. 3 is a block diagram exactly identical with FIG. 2 except the block 207' reversed with the logic with the block 207 in FIG. 2 and the newly added block 210. Therefore, in the flowchart in FIG. 3, the same number is marked to the block corresponding to the block of FIG. 2, and repeated description is omitted. In the following, description is emphasized exclusively on the difference with FIG. 2. /6

[0028]

In the block 207', the check code 17a transferred by the on board program reprogrammer 10 and the prescribed code 4a on the reprogrammable memory 4 are compared. If they match, identical with FIG. 2, switch the control to the transfer program. If they do not match, the entire or a portion of the code on the reprogrammable memory 4 is deleted and the confidentiality is kept.

[0029]

In the algorithm of this working example, the method of the aforementioned trial and error protection releasing is not used. Security of the system is improved. Therefore, since the code is unconditionally removed when matching of the check code is failed, therefore, there is a risk of that the code is rewritten from one again. As a countermeasure of this point, the algorithm can be changed so that the program is deleted only when matching of the check code failed the prescribed number of times.

[0030]

Also, as described above, matching of the check code is performed after fetching in the transfer program for reprogramming, but it can also be performed before fetching in the transfer program. Next, a flowchart according to another working example of this invention is shown in FIG. 4. FIG. 4 is a diagram based on FIG. 3 where the block 211 is added. The same

number is marked to the block corresponding to FIG. 2 and FIG. 3. The operations differ with FIG. 3 is described exclusively in the following.

[0031]

After fetching in the transfer program for reprogramming, if the prescribed address of the reprogrammable memory 4 is in the non-write-in state, then continuously skip the check code matching by the block 211. The algorithm only performs the necessary initial write-in operation of MCU 2, thus throughput can be improved.

[0032]

On the other hand, for example, the prescribed address discriminating the unwritten state by the block 211 is matched with the aforementioned code 4a. In the initial stage of the transfer program for the aforementioned reprogramming, the prescribed address is in the unwritten state. The check code is set up by providing to the next reprogramming in the prescribed address. Thus, the signal is shared for whether or not the check code is succeeded in the complete reprogramming. As a result, in the middle of program reprogramming, if any disorder occurred in the serial line, or the reprogramming control hanged up, the reprogramming program is not being deleted in the middle by operation of the aforementioned algorithm. Therefore, the reprogramming operation can be continued by memory block with

unfinished reprogramming, and the time required for block-out recovery is shortened.

[0033]

Next, a time chart of a conventional transfer program for reprogramming without using an interrupting function is indicated in FIG. 5 for the purpose of comparison with the working example of this invention. When one byte is received by the on board program reprogrammer 10 in the period of 501, the code of the reprogrammable memory 4 is renewed by the data in the immediately following period 502. A signal regarding the matter of capability of the following receiving is output on the serial communication line TX 12 in the continuing period 503. In the on board program reprogrammer 10, this signal is recognized, the next data is transferred in the period 504, and transfer per byte is performed by the hand shake operation.

[0034]

The algorithm is shown in FIG. 6 in the form of flowchart. In this flowchart, since the error detection of the received data and retransfer function are complicated, they are removed from the flowchart. In the block 601, the data from the on board program reprogrammer 10 is received, and the data is renewed in the block 602. If the entire program code that must be reprogrammed by the next block 603 is completely received, transfer is finished in 605. If there are codes remaining to be

received, return to the sending back block 601 so that the next receiving becomes possible in the block 604.

[0035]

The conventional method has the following drawbacks.

The receiving operation and write-in operation for the data cannot be performed synchronously as multitasking. Therefore, hand shake operation per each byte must be performed between the on board program reprogrammer 10 and the MCU 2. Thus, the transfer throughput is impossible to increase.

If the signal showing capability of receiving data, for example, the data 505 in FIG. 5, disappeared by noise on the serial line, the hand shake operation stops there and is impossible to continue. Also, there is no means for recognizing this phenomenon for the transfer program for reprogramming.

[0036]

In order to solve these programs, the result of improving the operation by using the receiving interrupting and timer interrupting according to the working example of this invention is shown in the time chart in FIG. 7. In FIG. 7, the data is gathered and sent in 4 bytes each by using the receiving interrupting. Also, the receiving operation and write-in operation are performed synchronously as multitasking, the transmission of the receivable signal 701 is thinned to 1 byte in receiving data 4 bytes. The transfer timing of the receivable

signal 701 can be thinned to the size of the data reception buffer in principle. Therefore, it is clear that the transfer throughput can be greatly improved.

[0037]

Also, after sending out the receivable signal 701, then wait for whether or not the next receiving data is transferred during the period T shown in the diagram. If it is not sent out, it is regarded as the receivable signal 701 disappeared on the line, and the receivable signal 702 is retransmitted (it is called time out process). The reliability of data transfer can be significantly improved. /7

[0038]

FIG. 8 is a flowchart of the above algorithm. The error detection and retransmission function for the receiving data is complicated, and they are removed from the flowchart in this flowchart. Blocks 820 through 823 show the process routine for receiving interruption. In the block 820, the timer interrupting permitted in the block 810 is prohibited, and the time out process is prevented from occurring. In the blocks 821 and 822, the data which is the interrupting factor is received and stored in the reception buffer in sequence. In the following block 823, the number of byte actually stored in the reception buffer is counted as the variable "n".

[0039]

On the other hand, in the block 801 for the reprogramming transfer program, whether or not data is existing in the reception buffer is checked. If it does not exist, then wait by the loop. If it exists, write in is performed by read-out from the buffer in the following blocks 802 and 803. In the following block 804, the data number read out from the reception buffer is counted by the variable "m". In the block 805, if there are data not being read out in the buffer, then return to the block 802 and perform discrimination. In the following block 806, whether or not the data number stored in the reception buffer is the regulated number of byte is checked. The regulated number of byte refers to the number of data sent from outside at one time, and it depends to the size of the reception buffer (it is 4 for the case of FIG. 7). If it reached to the regulated number of byte, then advance to the block 807. If it did not reach to the regulated number of byte, then form a loop with the block 805 immediately before, and wait for the data to store in the reception buffer by the reception interrupting process. In the block 807, whether or not the entire code that must be is reprogrammed is finished receiving is checked. If the reception is completed, then skip and finish in 811. Also, if the code that must be received is remaining, then clear the variable "n" and "m" in the block 808, and return the matter the next receiving is possible in the block 809. In the block 810, the

timer interrupting for time out processing is activated in the block 810, and return to the block 801.

[0040]

As shown in FIG. 7, when the period T is passed, the block 830 for the timer interrupting process is started, and the receivable signal is retransmitted if receiving is not carried out even one byte.

[0041]

[Effectiveness of this invention]

It is clear from the above description that with this invention, a control device for vehicles which can significantly improve security and protection and minimize the time wasted on disorder recovery without performing unnecessary security operation at the time of initial write-in of the program; also, the process of interruption process can be used for data transfer in the on-board rewriting operation; high speed and highly reliably protocol can be easily adopted; and it enables an on-board reloading system for vehicles configured inexpensively.

4. Brief Description of the Diagrams

FIG. 1 is internal block diagram showing a working example of this invention.

FIG. 2 is a flowchart showing a working example of this invention.

FIG. 3 is a flowchart showing another working example of

this invention.

FIG. 4 is a flowchart showing another working example of this invention.

FIG. 5 is a time chart of a conventional transfer program.

FIG. 6 is a flowchart of a conventional transfer program.

FIG. 7 is a time chart of a transfer program of this invention.

FIG. 8 is a flowchart of a transfer program of this invention.

[Description of numbers]

1... control system for vehicles, 2... one-chip microcomputer as MCU, 3... CPU, 4... flash ROM as the reprogrammable means, 6... boot program firmware as the reprogram control means, 7... RAM as the temporary memory, 10... on board reprogrammer, 11, 12... bidirectional serial communication line, 15... transfer program for reprogramming, 17... EPROM as the exchangeable recording media.

FIG. 5

1... receiving operation, 2... write-in operation, 3... transmission operation.

FIG. 2

A. Boot program start, 201... synchronous confirmation process, 202... receive "n" number of byte of transfer program, 203... receiving transfer program, 204... store in the temporary memory 7 (RAM), 205... It the number of receiving byte = n? 206... receive

check code 17a, 207... (not match) Is the code 17a = code 4a? 208... Jump to the transfer program on RAM, 209... finish the reprogramming mode.

FIG. 3

A. Boot program start, 201... synchronous confirmation process, 202... receive "n" number of byte of transfer program, 203... receiving transfer program, 204... store in the temporary memory 7 (RAM), 205... It the number of receiving byte = n? 206... receive check code 17a, 207... (match) Is the code 17a = code 4a? 210... (not match) delete the reprogrammable memory 4, B. Jump to the transfer program on RAM

FIG. 4

A. Boot program start, 201... synchronous confirmation process, 202... receive "n" number of byte of transfer program, 203... receiving transfer program, 204... store in the temporary memory 7 (RAM), 205... It the number of receiving byte = n? 211... Is the prescribed address of the reprogrammable memory 4 "unwritten?" 206... receive check code 17a, 207... (match) Is the code 17a = code 4a? 210... (not match) delete the reprogrammable memory 4, B. Jump to the transfer program on RAM

FIG. 6

A.Transfer program for reprogramming, 601... receive 1 byte, 602... write in 1 byte into the reprogrammable memory 4, 603... The prescribed receiving byte number? Receivable signal transmission,

605… finish.

FIG. 7

1… receiving interrupting, 2… timer interrupting, 3… receiving operation, 4… write-in operation, 5… transmission operation

FIG. 8

A. Transfer program for reprogramming, 801… n ? 0? 802… read out 1 byte from the receiving buffer, 803… read in 1 byte to the reprogrammable memory 4, 804… [illeg.] - m + 1, 805… m < n? 806… n = (the regulated number of receiving byte)? 807… the prescribed receiving byte number? 808… n <- 0 m <- 0, 809… receivable signal transmission, 810… timer interrupting permission after the time "T", 811… finish, 820… timer interrupting prohibiting, 821… 1 byte receiving, 822… write in 1 byte in the receiving buffer, n <- n +1, B. timer interrupting, 830… receivable signal retransmission, C. reception interraption.

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上する。

【００３８】以上のアルゴリズムをフローチャートにしたものが、図８である。なお、このフローチャートにおいても、受信データの誤り検出と再送機能は煩雑になるので、当該フローチャートから除外している。ブロック８２０から８２３までは、受信割り込みの処理ルーチンを示している。ブロック８２０では、ブロック８１０で許可したタイマ割り込みを禁止し、前述したタイム・アウト処理が発生しないようにしている。ブロック８２１及び、ブロック８２２では、割り込み要因となったデータを受信し、受信バッファに順次格納しておく。続くブロック８２３では、実際に受信バッファに格納されたバイト数を変数nとしてカウントする。

【００３９】一方、書き換え転送用プログラムのブロック８０１では、受信バッファにデータが存在するかどうか調べている。もし存在しないならばループによりこれを待ち、存在するならば、続くブロック８０２、８０３でバッファより読み出して書き込みを行う。次のブロック８０４では受信バッファより読み出したデータ数を変数mにてカウントする。ブロック８０５では、もしバッファにまだ読みだしていないデータがあるならば、ブロック８０２に戻る判定を行う。続くブロック８０６では、受信バッファに貯まったデータ数が規定のバイト数かであるかどうか調べる。規定のバイト数とは、一回に外部より送られてくるデータの個数を指し、受信バッファの大きさに依存する（図７の場合では４）。もし、規定のバイト数に達しているならばブロック８０７に進み、達してしなければ直前のブロック８０５と共にループを形成し、受信割り込み処理により受信バッファにデータが貯まるのを待つ。ブロック８０７では、書き換えるべきコードの全てが受信完了したかどうか調べている。受信が完了したならば、８１１に飛び終了する。まだ受信すべきコードが残っているならば、ブロック８０８で変数nとmをクリアし、ブロック８０９で次の受信が可能となった旨を返送する。ブロック８１０では、タイム・アウト処理用のタイマ割り込みを活性化させブロック８０１に戻る。

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【００４０】図７に図示したように期間Ｔが過ぎた時に、１バイトも受信が行われなかった場合は、タイマ割り込み処理のブロック８３０が起動し、受信可能信号を再送信する。

【００４１】

【発明の効果】以上説明から理解されるように、本発明によれば、プログラムの機密性、及び保護性を大幅に向上させるようになされ、しかも、プログラムの初期書き込み時に不必要なセキュリティー動作を行わずに、障害回復に費やす時間を最小限とすることができ、また、オン・ボード・書き換え動作におけるデータ転送に割り込み処理を使用することができるとともに、高速で且つ高信頼性のプロトコルを容易に採用することができ、かつ、自動車用オン・ボード・書き換えシステムを安価に構成することができる。

【図面の簡単な説明】

【図１】本発明の一実施例を示す内部ブロック図。

【図２】本発明の一実施例を示すフローチャート。

【図３】本発明の他の実施例を示すフローチャート。

【図４】本発明の他の実施例を示すフローチャート。

【図５】従来型転送プログラムのタイムチャート。

【図６】従来型転送プログラムのフローチャート。

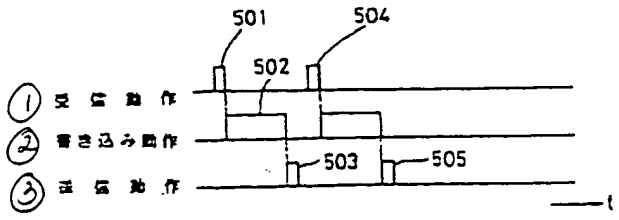
【図７】本発明による転送プログラムのタイムチャート

【図８】本発明による転送プログラムのフローチャート。

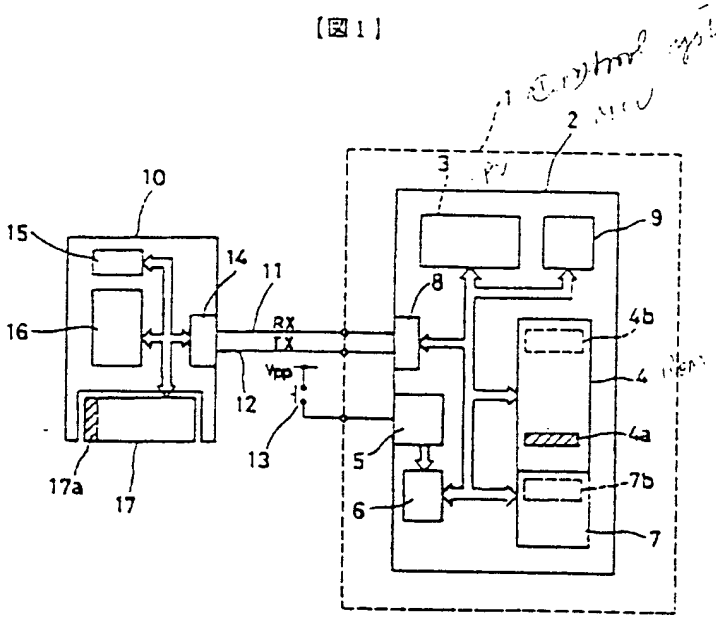
【符号の説明】

１…自動車用制御装置、２…ＭＣＵとしてのワンチップ・マイクロコンピュータ、３…ＣＰＵ、４…書き換え可能記憶手段としてのフラッシュＲＯＭ、６…書き換え制御手段としてのブート・プログラム・ファームウェア、７…一時記憶手段としてのＲＡＭ、１０…オン・ボード・書き換え機、１１，１２…双方向のシリアル通信回線、１５…書き換え用転送プログラム、１７…交換可能な記録媒体としてのＥＰＲＯＭ

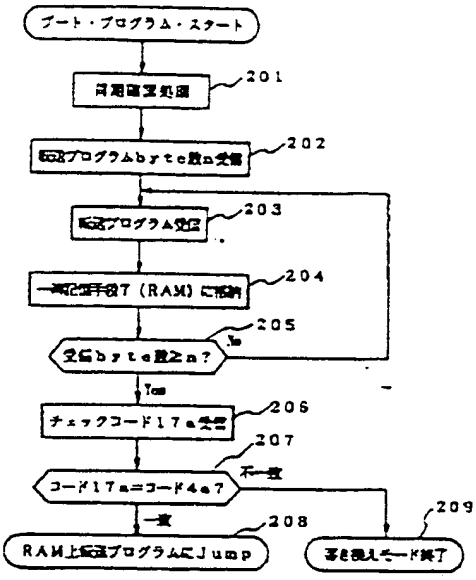
【図５】



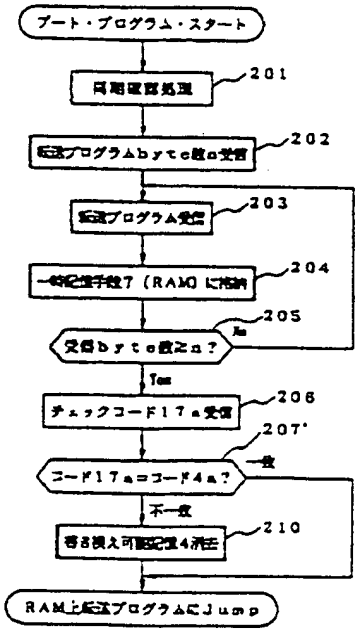
【図1】


1
2
3
4
4a
4b
5
6
7
7b
8
9
10
11
12
13
14
15
16
17
17a
RX
TX
Vpp

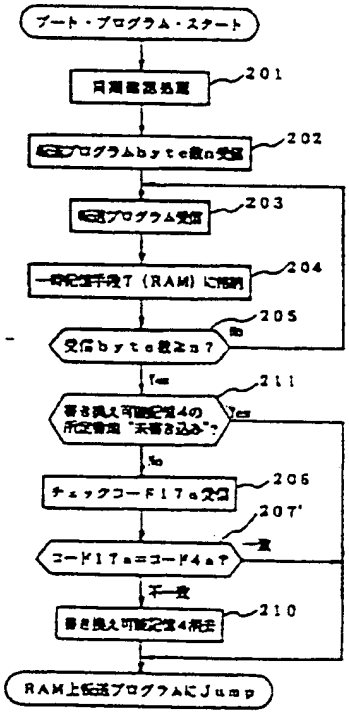
【図2】


ブート・プログラム・スタート
201
202
203
204
205
No
Yes
206
207
不一致
一致
208
209
RAM上転送プログラムにJump

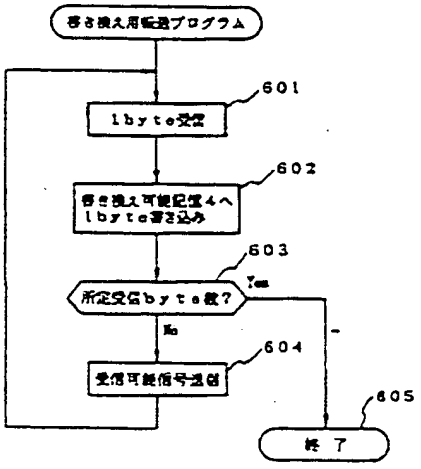
【図3】


ブート・プログラム・スタート
201
202
203
204
205
No
Yes
206
207'
一致
不一致
210
RAM上転送プログラムにJump

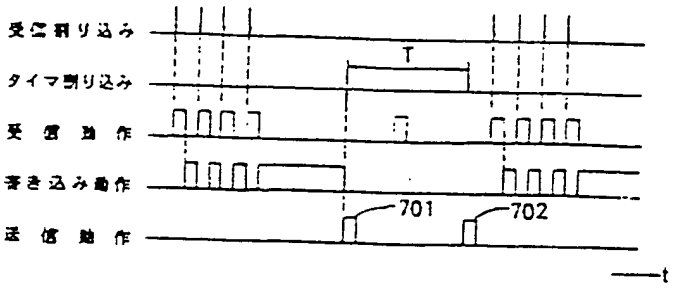
【図4】


ブート・プログラム・スタート
201
202
203
204
205
No
Yes
211
No
206
207'
一致
不一致
210
RAM上転送プログラムにJump

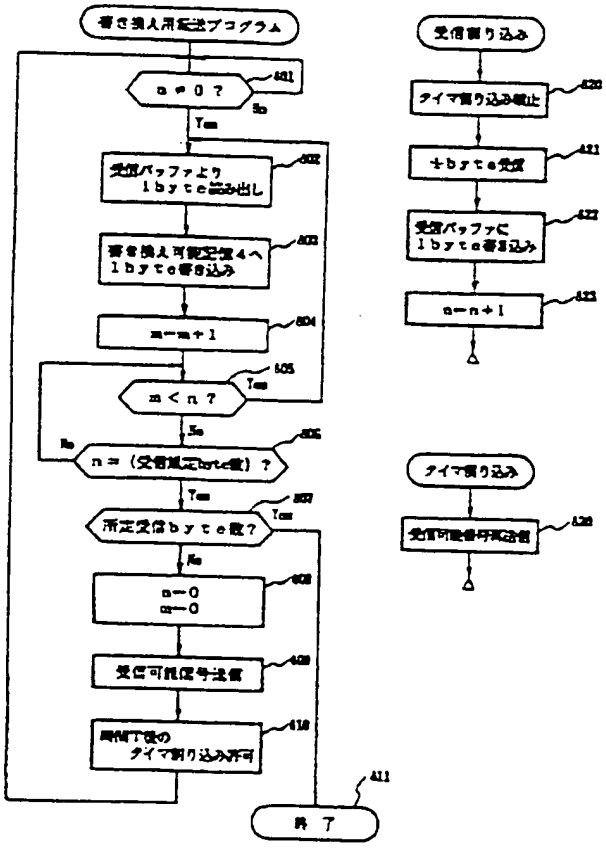
【図6】


601
602
603
Yes
No
604
605
終了

【図7】



【図8】



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